

APPENDIX I

PRELIMINARY ECOLOGICAL RISK ASSESSMENT

Technical Memorandum

**Preliminary Ecological Risk Assessment
For The
Former Rifle/Machine Gun Range, Parcel 104Q**

**Fort McClellan
Calhoun County, Alabama**

1.0 Introduction

This Technical Memorandum presents the Preliminary Ecological Risk Assessment (PERA) for the Former Rifle/Machine Gun Range, Parcel 104Q at Fort McClellan (FTMC) located in Calhoun County, Alabama. The PERA approach is a shortened version of the Screening-Level Ecological Risk Assessment (SLERA) protocol which has been developed for FTMC as a means to evaluate numerous sites in a uniform and economical way. It is assumed that the reader is familiar with FTMC and the fundamentals of the SLERA protocol presented in the Installation-Wide Work Plan (IT Corporation [IT], 1998). Each step of the PERA is described in the following sections.

2.0 Ecological Habitat Description

The Former Rifle/Machine Gun Range is approximately 8 acres in size and is located in the north-central area of FTMC Main Post. The site slopes towards the west, with MOUT Road bisecting the southern portion of the study area, Goode Road running along the western boundary of the study area and Osprey Road (a dirt road) running along the eastern boundary of the study area. The vast majority of the site is forested with a somewhat immature mixed deciduous/coniferous forest. Most of the canopy species are less than fifty years old and some individual trees are significantly younger. The cover species typically found in these forested areas include scrub pine (*Pinus virginiana*), loblolly pine (*Pinus taeda*), white oak (*Quercus alba*), post oak (*Quercus stellata*), chestnut oak (*Quercus prinus*), southern red oak (*Quercus falcata*), wild black cherry (*Prunus serotina*), hackberry (*Celtis occidentalis*), black walnut (*Juglans nigra*), and flowering dogwood (*Cornus florida*). These mixed deciduous/coniferous forests exhibit sparse, shade-tolerant undergrowth species such as *Parthenocissus quinquefolia* (Virginia creeper), *Polystichum acrotichoides* (Christmas fern), *Toxicodendron radicans* (poison ivy) and *Vitis rotundifolia* (muscadine grape). Understory and shrub species are typically sparse in this type of habitat. A mat of pine needles and leaves generally inhibits the growth of shrub and herbaceous layers within this forest type. Typical terrestrial species inhabiting this type of habitat include eastern gray squirrel (*Sciurus carolinensis*), whitetail deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), shorttail shrew (*Blarina brevicauda* or *Blarina carolinensis*), red fox (*Vulpes vulpes*), white-footed mouse (*Peromyscus leucopus*), American robin (*Turdus migratorius*), and red-tailed hawk (*Buteo jamaicensis*).

There are no water bodies or wetlands associated with the Former Rifle/Machine Gun Range, Parcel 104Q.

3.0 Media of Interest and Data Selection

The medium of interest at Parcel 104Q is surface soil. Since there are no wetlands or surface water bodies associated with this site, surface water and sediment exposures are not applicable. Exposures to subsurface soil and groundwater are unlikely for ecological receptors at this study area. Twenty-two surface soil and depositional soil samples were collected and analyzed for metals and explosives. Two of these surface soil samples were also analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), pesticides, and herbicides.

4.0 Identification of Constituents of Potential Ecological Concern

In order to determine whether constituents detected in environmental samples collected at the Former Rifle/Machine Gun Range have the potential to pose adverse ecological risks, screening-

level hazard quotients were developed. The screening-level hazard quotients were developed via a three-step process as follows:

- Comparison to ecological screening values (ESV);
- Identification of essential macronutrients; and
- Comparison to naturally occurring background concentrations.

The ESVs used in this assessment represent the most conservative values available from various literature sources and have been selected to be protective of the most sensitive ecological assessment endpoints. These ESVs have been developed specifically for FTMC in conjunction with USEPA Region 4 and are presented in the *Final Human Health and Ecological Screening Values and PAH Background Summary Report* (IT, 2000). The ESVs used in this assessment are based on no-observed-adverse-effect-levels (NOAEL) when available. If a NOAEL-based ESV was not available for a certain constituent, then the most health-protective value available from the scientific literature was used in this assessment.

Constituents that were detected in surface soil at the Former Rifle/Machine Gun Range were evaluated against the ESVs by calculating a screening-level hazard quotient (HQ_{screen}) for each constituent. An HQ_{screen} was calculated by dividing the maximum detected constituent concentration in surface soil by its corresponding ESV as follows:

$$HQ_{\text{screen}} = \frac{MDCC}{ESV}$$

where:

HQ_{screen}	=	screening-level hazard quotient;
$MDCC$	=	maximum detected constituent concentration; and
ESV	=	ecological screening value.

A calculated HQ_{screen} value of one indicated that the MDCC was equal to the chemical's conservative ESV and was interpreted in this assessment as a constituent that does not pose the potential for adverse ecological risk. An HQ_{screen} value less than one indicated that the MDCC was less than the conservative ESV and that the chemical is not likely to pose adverse ecological hazards to most receptors. Conversely, an HQ_{screen} value greater than one indicated that the MDCC was greater than the ESV and that the chemical might pose adverse ecological hazards to one or more receptors.

In order to better understand the potential risks posed by chemical constituents at the Former Rifle/Machine Gun Range, a mean hazard quotient was also calculated by comparing the arithmetic mean constituent concentration in surface soil to the corresponding ESV. The calculated screening-level hazard quotients for constituents in surface soil at the Former Rifle/Machine Gun Range are presented in Table 1.

The USEPA recognizes several constituents in abiotic media that are necessary to maintain normal function in many organisms. These essential macronutrients are iron, magnesium,

calcium, potassium, and sodium (USEPA, 1989). Most organisms have mechanisms designed to regulate nutrient fluxes within their systems; therefore, these nutrients are generally only toxic at very high concentrations. Although iron is an essential nutrient and is regulated within many organisms, it may become increasingly bioavailable at lower pH values, thus increasing its potential to elicit adverse affects. Therefore, iron was not evaluated as an essential nutrient in this PERA. Essential macronutrients were considered COPECs only if they were present in site samples at concentrations ten times the naturally-occurring background concentration.

The comparison of detected constituent concentrations with naturally occurring constituent concentrations was conducted via a three-tier process outlined in a technical memorandum dated June 24, 2003 (Shaw Environmental, Inc. [Shaw], 2003). The first tier of the background comparison process was a comparison of the maximum detected constituent concentration to the background threshold value (BTV). A study of the natural geochemical composition associated with FTMC (SAIC, 1998) determined the mean concentrations of 24 metals in surface soil, surface water, sediment, and groundwater samples collected from presumably unimpacted areas. Per agreement with USEPA Region 4, the background threshold value (BTV) for each metal was calculated as two times the mean background concentration for that metal. The BTV for each metal was used to represent the upper boundary of the range of natural background concentrations expected at FTMC, and was used as the basis for evaluating metal concentrations measured in site samples. Site sample metal concentrations less than or equal to the corresponding BTV represent the natural geochemical composition of media at FTMC, and not contamination associated with site activity. Site sample metal concentrations greater than the corresponding BTV require further background assessment.

If maximum constituent concentrations were greater than the BTV, then the second tier of the background comparison was employed. Tier two of the background comparison consists of statistical comparisons of the site data to background data using the Slippage Test and the Wilcoxon Rank Sum (WRS) Test. If the site data failed either the Slippage Test or the WRS Test, then the site data were subjected to a geochemical evaluation (Tier 3) to determine whether concentrations of inorganic compounds are naturally occurring or are elevated due to contamination. The statistical and geochemical evaluations are provided separately in the site investigation report.

Thus, the first step in determining screening-level hazard quotients was a comparison of maximum detected constituent concentrations to appropriate ESVs. Constituents with HQ_{screen} values less than or equal to one were considered to pose insignificant ecological risk and were eliminated from further consideration. Constituents with HQ_{screen} values greater than one were eliminated from further consideration if they were macronutrients and were present at concentrations less than ten-times the naturally occurring levels. Those constituents that had HQ_{screen} values greater one and were not considered macronutrients were then compared to background using the three-tier background screening process. If constituent concentrations were determined to be less than their naturally occurring background concentrations, then a risk management decision could result in eliminating these constituents from further assessment.

The constituents in surface soil at the Former Rifle/Machine Gun Range that exceeded their respective ESVs, were not essential macronutrients, and were detected at concentrations greater than naturally occurring levels are presented in Table 1 and are summarized below:

- 4,4'-DDT
- MCPA
- dieldrin
- endrin.

Additional lines of evidence are sometimes useful in determining whether a certain constituent is in fact site-related and a COPEC. Some of the additional lines of evidence used in the process of identifying COPECs include: 1) frequency of detection, 2) magnitude of the HQ_{screen} value, 3) spatial distribution, 4) alternative ESVs; and 5) association of a chemical with known Army activities. These additional lines-of-evidence were used to further define the COPECs at the Former Rifle/Machine Gun Range.

Surface Soil COPECs. One herbicide (MCPA) and three pesticides (4,4'-DDT, dieldrin, and endrin) were detected in surface soil at concentrations that exceeded their respective ESVs. These herbicides and pesticides were detected in a single sample from the northern boundary of the study area. This sample was collected from a location adjacent to the firing line, implying that these herbicides and pesticides could be the result of historical weed and pest control activities. The maximum HQ_{screen} values for 4,4'-DDT, MCPA, dieldrin, and endrin were calculated to be 1.1, 11.0, 7.0, and 2.2, respectively.

One surface soil sample (location HR-104Q-GP01) out of 2 samples analyzed for pesticides exhibited a 4,4'-DDT concentration that exceeded the ESV. The calculated HQ_{screen} value for 4,4'-DDT was 1.1. An alternative ESV of 0.0035 mg/kg could be considered for 4,4'-DDT, based on exposures to masked shrews (USEPA Region 5, 2003). The detected concentration of 4,4'-DDT was less than the alternative ESV. Based on the infrequency of detection, the low magnitude of the HQ_{screen} value, and the fact that the detected concentration is less than the alternative ESV, 4,4'-DDT was not considered a COPEC in surface soil at the Former Rifle/Machine Gun Range.

One surface soil sample (location HR-104Q-GP01) out of 2 samples analyzed for herbicides exhibited a MCPA concentration that exceeded the ESV. Studies of the fate and transport of MCPA have shown that MCPA is rapidly degraded by soil microorganisms and it has low persistence, with a reported half-life of 14 days to one month. It's residual activity in soil is about 2 months (EXTOXNET, 2003). Because this range has not been active for a number of years, it is expected that the MCPA detected in soil no longer exhibits any residual activity. Additionally, MCPA has been shown to be only slightly toxic to wildfowl (LC_{50} for bobwhite quail = 377 mg/kg), slightly toxic to freshwater fish (LC_{50} values for rainbow trout range from 117 to 232 mg/L), and practically nontoxic to freshwater invertebrates. Based on the infrequency of detection and it's low potential for long-term toxicity, MCPA was not identified as a COPEC in surface soil at the Former Rifle/Machine Gun Range.

Dieldrin and endrin were detected in one surface soil sample (location HR-104Q-GP01), which is the same sample that exhibited the detection of MCPA and 4,4'-DDT. The calculated HQ_{screen} values for dieldrin and endrin were 7.0 and 2.2, respectively. USEPA Region 5 (2003) Ecological Screening Levels could be considered alternative ESVs for dieldrin (0.00238 mg/kg) and endrin (0.0101 mg/kg). The detected concentration of dieldrin is slightly greater than the alternative ESV (HQ_{screen} value = 1.5), and the detected concentration of endrin is less than the alternative ESV (HQ_{screen} value = 0.22). Based on the infrequency of detection, the low magnitude of the HQ_{screen} values, and the fact that the detected concentration of endrin is less than the alternative ESV, dieldrin and endrin were not considered COPECs in surface soil at the Former Rifle/Machine Gun Range.

5.0 Ecological Risk Characterization

The Former Rifle/Machine Gun Range is almost entirely forested with a relatively immature mixed deciduous/coniferous forest. There are no surface water bodies or wetlands on-site or in the adjacent areas. Therefore, surface soil was the only environmental medium of interest at this site.

All of the inorganic constituents and VOCs detected in soil were detected at concentrations less than ESVs and/or naturally-occurring levels. Several organic constituents in surface soil exceeded their ESVs.

One herbicide (MCPA) and three pesticides (4,4'-DDT, dieldrin, and endrin) were detected in surface soil at concentrations that exceeded their respective ESVs. These herbicides and pesticides were detected in a single sample from the northern boundary of the study area. This sample was collected from a location adjacent to the firing line, implying that these herbicides and pesticides could be the result of historical weed and pest control activities. The maximum HQ_{screen} values for 4,4'-DDT, MCPA, dieldrin, and endrin were calculated to be 1.1, 11.0, 7.0, and 2.2, respectively.

One surface soil sample (HR-104Q-GP01) out of 2 samples analyzed for pesticides exhibited a 4,4'-DDT concentration that exceeded the ESV; however, the detected concentration was less than the alternative ESV. Based on the infrequency of detection, the low HQ_{screen} value, and the fact that the detected concentration was less than the alternative ESV, 4,4'-DDT was not considered a COPEC in surface soil at the Former Rifle/Machine Gun Range.

MCPA was detected in one surface soil sample at a concentration that exceeded the ESV. MCPA is rapidly degraded by soil microorganisms and it has low persistence, with a reported half-life of 14 days to one month. Its residual activity in soil is about 2 months (EXTOXNET, 2003). Because this range has not been active for a number of years, it is expected that the MCPA detected in soil no longer exhibits any residual activity. Therefore, MCPA was not identified as a COPEC in surface soil at the Former Rifle/Machine Gun Range.

Dieldrin and endrin were detected in one surface soil sample at concentrations that exceeded their respective ESVs. If alternative ESVs are considered, then the HQ_{screen} value for dieldrin is 1.5 and the detected concentration of endrin is less than the alternative ESV. Based on the infrequency of detection, the low magnitude of the HQ_{screen} values, and the fact that the detected

concentration of endrin is less than the alternative ESV, dieldrin and endrin were not considered COPECs in surface soil at the Former Rifle/Machine Gun Range.

Because these herbicides and pesticides were only detected in a single sample at this site, it could be concluded that these constituents are not widely distributed within the study area. Larger animals with relatively large home ranges and foraging habitats would not be expected to be adversely affected by this localized, low-level contamination.

6.0 Uncertainty Evaluation

A number of uncertainties are inherent in the PERA process, the vast majority of which err on the side of ecological protectiveness. One significant source of uncertainty that may impart a non-conservative bias on the PERA results is the exclusion of metals determined to be present at concentrations comparable to naturally occurring background concentrations from consideration as COPECs. The chemicals excluded from selection as COPECs based solely on their comparison to background concentrations are discussed below.

As noted above, the exclusion of chemicals from the list of COPECs based on comparison to naturally-occurring levels is performed via a three-tiered protocol (Shaw, 2003). Tier 1 – comparison of the maximum detected constituent concentration to the BTV – is generally considered to be sufficiently conservative so that the uncertainty associated with chemicals eliminated in this tier of the protocol is minimal. Therefore, only chemicals excluded as COPECs via tiers 2 or 3 of the background screening protocol are discussed herein.

Chromium was the only constituent eliminated as a COPEC solely on the basis of the statistical comparison of site data with naturally occurring levels. Both statistical tests (Wilcoxon Rank Sum and Slippage Test) (USEPA Region 4, 1998) indicated chromium concentrations in surface soil at the Former Rifle/Machine Gun Range were comparable to background concentrations. Therefore, the exclusion of chromium from the list of COPECs was considered to introduce a minimal level of uncertainty into this PERA.

Aluminum, manganese, and mercury were eliminated as COPECs solely on the basis of the geochemical comparison of site data with naturally-occurring levels. Per USEPA (2000) guidance, aluminum toxicity is associated with soluble aluminum only. Numeric screening values for aluminum are considered inappropriate. Alternatively, potential ecological risks associated with exposure to aluminum are associated with soil pH. Aluminum is identified as a COPEC only if the soil pH is less than 5.5 (USEPA, 2000). Since the pH of soils at the Former Rifle/Machine Gun Range is greater than 5.5, the exclusion of aluminum from the list of COPECs introduced minimal uncertainty into this PERA.

Two surface soil samples out of 22 exhibited mercury concentrations that exceeded the ESV. The HQ_{screen} value for mercury was 1.5. However, if alternative screening values of 0.349 mg/kg (Panda, et al., 1992; based on toxicity to terrestrial plants) or 2.5 mg/kg (Beyer, et al., 1985; based on toxicity to terrestrial invertebrates) are considered, none of the detected mercury concentrations are greater than these alternative screening values. Therefore, based on the low frequency of detection above the ESV, the low magnitude of the HQ_{screen} value, and the fact that the detected values are less than alternative ESVs, the exclusion of mercury from the list of

COPECs was considered to introduce a minimal level of uncertainty into this PERA. The exclusion of manganese from the surface soil COPECs remains a source of uncertainty in this PERA.

Another source of uncertainty in this PERA is the use of highly conservative ESVs that may not be directly applicable to this site. The ESVs used for comparison are very conservative and are designed to be protective of the most sensitive individual organism. Specifically, the ESVs for the pesticides and herbicides initially identified as COPECs at the Former Rifle/Machine Gun Range were derived in the Netherlands as “target values,” which are protective levels intended to achieve desired soil quality in the Netherlands (Ministry of Housing, Spatial Planning, and Environment, 1994). As such, these screening values may not be applicable to conditions at FTMC.

7.0 Summary and Conclusions

In summary, twenty-two surface soil and depositional soil samples were collected and analyzed for metals and explosives. Two of these surface soil samples were also analyzed for VOCs, SVOCs, pesticides, and herbicides. Low levels of VOCs, pesticides, and herbicides were detected in surface soil. A number of metals were also detected.

All of the detected VOCs were present at concentrations less than their respective ESVs. All of the metals either were detected at concentrations less than their ESVs or were detected at concentrations that were determined to be comparable to naturally occurring levels. The herbicide MCPA and the pesticides 4,4'-DDT, dieldrin, and endrin were initially identified as COPECs, but additional lines of evidence indicated that these constituents should not be included as COPECs in surface soil.

Therefore, it is unlikely that the constituents detected in surface soil at the Former Rifle/Machine Gun Range, Parcel 104Q pose significant ecological risk based on the infrequency of detection, the limited aerial extent of the detected constituents, and the concentrations at which these constituents were detected.

8.0 References

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TABLE 1
CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN IN SURFACE SOIL
Former Rifle / Machine Gun Range (Parcel 104Q)
Fort McClellan, Calhoun County, Alabama

Detected Constituents	Background Threshold Value ^a (mg/kg)	Ecological Screening Value ^b (mg/kg)	Frequency of Detection	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Mean Detected Concentration (mg/kg)	Maximum Hazard Quotient	Mean Hazard Quotient	Constituent of Potential Ecological Concern
Volatiles :									
2-Butanone	NA	89.6	2 of 2	0.032	0.018	0.025	0.00036	0.00028	1
Acetone	NA	2.5	2 of 2	0.79	0.22	0.505	0.316	0.202	1
p-Cymene	NA	NA	1 of 2	0.0027	0.0018	0.00225	ND	ND	6
Metals :									
Aluminum	16,300	50	22 of 22	27,200	6,010	13643.18	544.00	272.86	5
Arsenic	13.7	10	22 of 22	6.73	1.33	3.68	0.67300	0.36782	1,3,4
Barium	124	165	22 of 22	154	31	76.47	0.93333	0.46344	1,5
Beryllium	0.8	1.1	12 of 22	0.772	0.365	0.55	0.70182	0.50004	1,3,5
Calcium	1,720	NA	22 of 22	1,450	202	503.86	ND	ND	2,3,5
Chromium	37	0.4	22 of 22	74.3	2.92	13.92	185.750	34.803	4
Cobalt	15.2	20	22 of 22	6.34	1.84	3.97	0.31700	0.19848	1,3,4
Copper	12.7	40	22 of 22	16.2	2.23	6.17	0.40500	0.15413	1,4
Iron	34,200	200	22 of 22	23,100	2,790	10,925	115.500	54.625	2,3,4
Lead	40.1	50	22 of 22	46	8.36	22.80	0.920	0.456	1,5
Magnesium	1,030	440,000	22 of 22	709	190	412.95	0.00161	0.00094	1,2,3,4
Manganese	1,580	100	22 of 22	2,400	138	929.23	24.000	9.292	5
Mercury	0.08	0.1	20 of 22	0.15	0.0328	0.07	1.500	0.660	5
Nickel	10.3	30	22 of 22	10.5	3.08	6.02	0.350	0.201	1,5
Potassium	800	NA	22 of 22	584	133	360.91	ND	ND	2,3,4
Sodium	634	NA	19 of 22	78.5	56.6	62.03	ND	ND	2,3,4
Vanadium	58.8	2	22 of 22	45.6	5.81	20.49	22.800	10.245	3,4
Zinc	40.6	50	22 of 22	23.9	7.4	17.36	0.478	0.347	1,3,4
Herbicides :									
MCPA	NA	0.1	1 of 2	1.1	0.93	1.02	11.000	10.150	YES ⁷
Pesticides :									
4,4'-DDE	NA	0.0025	1 of 2	0.0024	0.0024	0.0023	0.960	0.920	1
4,4'-DDT	NA	0.0025	1 of 2	0.0028	0.0028	0.0025	1.120	1.000	YES ⁷
alpha-Chlordane	NA	0.1	1 of 2	0.0011	0.00068	0.0009	0.0110	0.0089	1
delta-BHC	NA	9.94	1 of 2	0.0011	0.00034	0.00072	0.00011	0.00007	1
Dieldrin	NA	0.0005	1 of 2	0.0035	0.0035	0.0029	7.00	5.70	YES ⁷
Endosulfan II	NA	0.119	1 of 2	0.0024	0.0024	0.0023	0.02017	0.01933	1
Endrin	NA	0.001	1 of 2	0.0022	0.0019	0.0021	2.20	2.05	YES ⁷

TABLE 1
CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN IN SURFACE SOIL
Former Rifle / Machine Gun Range (Parcel 104Q)
Fort McClellan, Calhoun County, Alabama

Detected Constituents	Background Threshold Value ^a (mg/kg)	Ecological Screening Value ^b (mg/kg)	Frequency of Detection	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Mean Detected Concentration (mg/kg)	Maximum Hazard Quotient	Mean Hazard Quotient	Constituent of Potential Ecological Concern
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^a Background threshold value is two times (2x) the arithmetic mean of background metals (SAIC, 1998). For SVOCs, the BTV is the background screening value for soils adjacent to asphalt as given in IT Corporation (IT), 2000, *Final Human Health and Ecological Screening Values and PAH Background Summary Report, Fort McClellan, Calhoun County, Alabama*, July.

^b Ecological Screening Values (ESV) are presented in *Human Health and Ecological Screening Values and PAH Background Summary Report* (IT, 2000).

NA - Not available. ND - Not determined.

Rationale for inclusion / exclusion as a COPEC:

- 1 - Maximum detected concentration is less than ESV
- 2 - Essential macro-nutrient, only toxic at extremely high concentrations (i.e. 10-times naturally-occurring background concentrations).
- 3 - Maximum detected concentration is less than the background threshold value (BTV).
- 4 - Slippage Test and Wilcoxon Rank Sum Test indicate the concentration of this constituent is statistically similar to background concentrations.
- 5 - Geochemical evaluation of the data indicate that this constituent is naturally occurring.
- 6 - No ESV available; however, maximum detected concentration of this constituent is less than ESV for similar compounds.
- 7 - Additional lines of evidence indicate that this constituent may not be a COPEC (see text).